THE INFLUENCE OF VARIOUS DOSES OF CALCIUM AND MAGNESIUM ON BROILER CHICKENS PERFORMANCE PARAMETERS

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Abstract: The aim of this study was to determine the influence of lower doses of calcium and magnesium in the diet on performance parameters of broiler chickens. The purpose of the research is reduction of Ca and Mg contents in premixes. Calcium was supplemented using $CaCO_3$ and magnesium by $MgSO_4$. The basal diet contains 2.33 g Ca and 1.58 g Mg per kilogram. Control group received feed mixture with added $CaCO_3$ in dose of 19.485 g · kg^{-1} and 0.407 g · kg^{-1} of $MgSO_4$. Three experimental groups contain added $CaCO_3$ in dose of 11.832 g · kg^{-1} and 0 g · kg^{-1} $MgSO_4$; $CaCO_3$ 11.832 g · kg^{-1} and 0.407 g · kg^{-1} $MgSO_4$; $CaCO_3$ 19.485 g · kg^{-1} and 0 g · kg^{-1} $MgSO_4$ (groups Exp1; Exp2; Exp3, respectively). In the trial feed intake and live weight of chickens were monitored. The experiment was conducted from day 11 to day 36 of chickens age. At the end of trial experimental animals were weighed and slaughtered. Feathers were removed and chickens were eviscerated. Carcass yield was calculated. Selected chickens were deboned and breast muscle and leg muscle were weighed. Subsequently, these values were calculated by the percentage of live weight of breast and leg muscle. Dose reduction of Ca and Mg in the feed ration had no negative influence on the monitored parameters in broiler fattening. Comparison of the results with the control group did not show worsening parameters of fattening. Differences between groups in performance parameters were not significant ($P>0.05$).

Key Words: calcium, magnesium, carcass yield, poultry nutrition

INTRODUCTION

Minerals such as calcium, phosphorus and magnesium have important biological functions and must be provided in adequate amounts in poultry diets (Blair 2008). After hatching the broiler skeleton is poorly mineralized. The highest intensity of growth of skeletal tissue occurs the first 2 weeks after chickens hatched (Angel 2007). The requirement to calcium is highest early in life, when the fractional growth rate is highest, and decreases as adult body weight is reached (NRC 1994). Recommended nutrient content by Zelenka et al. (2007) indicates the delivered amount of calcium and magnesium in feed mixtures for fattening chickens 9 g · kg^{-1} of calcium and 0.5 g · kg^{-1} of magnesium. Approximately 90% of calcium and 60–70% of magnesium in the body is represented in the skeleton (Suttle 2010). Calcium is an essential nutrient for many biochemical processes, the strength and integrity of the skeletal tissues. Calcium deficiency can lead to skeletal deformations rickets and tibial dyschondroplasia, fractures and neural weakness (Abdollahi 2015). Magnesium has the basic functions in the cell metabolism and bone development (Shastak, Rodehutscord 2015). Magnesium deficiency in growing poultry is characterised by poor growth and feathering, incoordination, convulsive attacks, coma, and death. In laying hens, symptoms include reduced egg production, hypomagnesemia, decreased feed consumption, nervous tremors, and seizures (Morii 2007). Yang et al. (2012) reported that dietary $MgSO_4$ supplementation significantly prevented heat stress-induced oxidative damage and improved growth performance in broilers compared with that of control because of restoration of the activity of anti-oxidative enzymes.

The aim of this study was to determine the influence of lower doses of calcium and magnesium in the diet on performance parameters of broiler chickens. The purpose of the research is reduction of Ca and Mg contents in premixes.

MATERIAL AND METHOD

An experiment was performed with cockerels of Ross 308 hybrid (n = 120) which were fattened in cage batteries from day 11th to 36th day of age. Cockerels were divided into 4 groups in four replications. It was determined contain of Ca and Mg in the feed components and subsequently was balanced to the desired values. The basal diet contains 2.33 g Ca and 1.58 g Mg per kilogram. The composition of the basal diet is shown in Table 2.

Calcium was completed using $CaCO_3$ and magnesium by $MgSO_4$. Control group received feed mixture with added $CaCO_3$ in dose of 19.485 g · kg^{-1} and 0.407 g · kg^{-1} of $MgSO_4$. Three experimental groups contain added $CaCO_3$ in dose of 11.832 g · kg^{-1} and 0 g · kg^{-1} $MgSO_4$; $CaCO_3$ 11.832 g · kg^{-1} and 0.407 g · kg^{-1} $MgSO_4$; $CaCO_3$ 19.485 g · kg^{-1} and 0 g · kg^{-1} $MgSO_4$ (groups Exp1; Exp2; Exp3, respectively). See Table 1.

The crumbly feed mixture was supplied *ad-libitum* and its consumption was recorded every day. Access to drinking water was also *ad-libitum*. Weighing of chickens was carried out on the start and on the end of trial. Microclimate and lighting regime was modified according to the technological instructions of Ross 308. The values of microclimate were recorded every day. During the experiment was no found mortality.

The experimental animals were weighed and slaughtered. In selected chickens (n = 10) were weights carcass yield. In these selected chickens were deboned and weighed breast muscle and leg muscle. These values were calculated by the percentage of live weight.

Table 1 Addition of $CaCO_3$ and $MgSO_4$ (g · kg^{-1}) and total levels of Ca and Mg (g · kg^{-1}) in the diets

	C	Exp1	Exp2	Exp3
$CaCO_3$	19.485	11.832	11.832	19.485
$MgSO_4$	0.407	0	0.407	0
Total Ca	9	6	6	9
Total Mg	2.08	1.58	2.08	1.58

Table 2 Composition of the basal diet (g · kg^{-1})

Component	C	Exp1	Exp2	Exp3
Corn	340	340	340	340
Wheat	310	310	310	310
Soybean meal	260	260	260	260
Sunflower oil	40	40	40	40
Vitamin-mineral premix*	20	20	20	20
Experimental premix**	25	25	25	25
Chromium oxide	5	5	5	5

**Legend: premix content of one kg: lysine 101.65 g.kg^{-1}, methionine 135.63 g.kg^{-1}, threonine 51.22 g.kg^{-1},calcium 68.31 g.kg^{-1}, phosphorus 98.19 g.kg^{-1}, natrium 62.89 g.kg^{-1}, magnesium 4.7 g.kg^{-1}, sulphur 0.39 g.kg^{-1}, chlorine 119.69 g.kg^{-1}, copper 752.5 mg.kg^{-1}, iron 3768.6 mg.kg^{-1}, zinc 3400 mg.kg^{-1}, manganese 6046.07 mg.kg^{-1}, cobalt 11 mg.kg^{-1}, iodine 47.95 mg.kg^{-1}, selenium 8.96 mg.kg^{-1}, retinol 680000 IU, cholecalciferol 250000 IU, alfatocoferol 2250 mg.kg^{-1}, K3 74.8 mg.kg^{-1}, B1 206.44 mg.kg^{-1}, B2 344 mg.kg^{-1}, B6 300.44 mg.kg^{-1}, B12 1999.2 mg.kg^{-1}, biotin 11 mg.kg^{-1}, niacinamid 1793.4 mg.kg^{-1}, calcium pantothenate 676.2 mg.kg^{-1}, folic acid 82.8 mg.kg^{-1}, choline chlorid 9000 mg.kg^{-1}*

***Experimental premix: Content different levels of $CaCO_3$ and $MgSO_4$ according to Table 1*

Data has been processed by Microsoft Excel (USA) and Statistica version 12.0 (CZ). We used one-way analysis (ANOVA). To ensure statistical differences Sheffe´s test was applied and differences were considered significant at P<0.05.

RESULTS AND DISCUSSION

Feed consumption

Feed consumption data (Table 3) revealed not significant differences. The highest mean feed consumption was (3 495.89 ± 1 078.82 g) in Exp3. Against it the lowest consumption was observed in C group (3 348.90 ± 1 014.64 g).

Van Der Hoeven-Hangoor et al. (2013) observed feed consumption 3 484 g/broiler from 14 d to 36 d of broilers age in their trial when fed $MgSO_4$ at dose of 0.255 g · kg^{-1}.

Rama Rao et al. (2003) fed chickens diet with calcium supplement of 7 g · kg^{-1} and found feed intake 2 558 g per chicken. In our experiment we found a higher feed intake in the trial.

Table 3 Average total feed consumption per chicken and trial

Group	n	Mean (g) ± standard deviation		
C	30	3348.90[a]	±	1014.64
Exp1	30	3468.13[a]	±	1055.30
Exp2	30	3487.14[a]	±	1160.49
Exp3	30	3495.89[a]	±	1078.82

a – mean statistically significant differences (P<0.05)

Body weight gain

Table 4 Mean live weight and body weight gain of chickens

Group	C			Exp1			Exp2			Exp3		
	Mean (g) ± standard deviation											
Start of the trial	311.10[a]	±	17.48	312.17[a]	±	19.65	313.90[a]	±	19.85	313.00[a]	±	18.00
End of the trial	1955.27[a]	±	280.92	2129.90[a]	±	257.33	2126.53[a]	±	212.81	2081.30[a]	±	231.26
Body weight gain per trial	1611.03			1817.73			1758.20			1751.20		

a – mean statistically significant differences (P<0.05)

The highest average body weight at the end of fattening was achieved in the experimental group Exp1 with value 2 129.90 ± 257.33 g, while the lowest weight was observed in the control group 1 955.27 ± 280.92 g (Table 4). The differences were not significant (P>0.05). According to the technological procedure for ROSS 308, the average body weight of cockerels would be 2 388 g at 36 days of age (Anonymous 2014).

Van Der Hoeven-Hangoor et al. (2013) observed in their trial when fed $MgSO_4$ at dose of 0.255 g · kg^{-1}, the weight of chickens at the end of experimental period (36 day of age) 2 064 g. In our trial we found in group Exp2 body weight of chickens at the end of experimental period 2 126.53 g.

Delezie et al. (2012) found in their experiment by using feed mixture with a content of 0.60% calcium in the grower and 0.52% of calcium in the finisher feed mixture body weight at the end of the experiment 2 752 g.

The highest carcass yield was found in the experimental group 3 (73.40 ± 1.91%). The lowest mean carcass yield (72.40 ± 1.73%) was found in the control group (Table 5). The differences among groups were not statistically significant. Carcass yield stated in the technological procedure for ROSS 308 (Anonymous 2014) is 71.72% for 2 000 g live weight.

Percentages of breast muscle of body weight were highest for group Exp1 (21.48 ± 1.96%), while the lowest value was observed in the control group (20.24 ± 2.16%) but differences among all groups were not significant. In the manual of hybrid Ross 308 (Anonymous 2014) is stated similar percentage of breast muscle of body weight to our results.

Carcass yield

Table 5 Carcass yield

Group	n	Carcass			Breast meat			Leg meat without bone		
		Mean (%) ± standard deviation								
C	10	72.40[a]	±	1.73	20.24[a]	±	2.16	14.91[a]	±	0.86
Exp1	10	73.15[a]	±	1.71	21.48[a]	±	1.96	15.34[a]	±	0.48
Exp2	10	73.11[a]	±	1.65	20.79[a]	±	1.66	15.13[a]	±	1.27
Exp3	10	73.40[a]	±	1.91	20.48[a]	±	2.33	14.97[a]	±	1.07

a – mean statistically significant differences (P<0.05)

Percentages of leg meat of body weight was attempted highest for Exp1 group (15.34 ± 0.48%), while the lowest value was observed in control group (14.91 ± 0.86%). The differences among all groups were not significant. The manual for the hybrid Ross 308 (Anonymous 2014) indicates a yield of leg meat 16.01% for 2 000 g live weight.

CONCLUSION

Dose reduction of Ca and Mg in the feed ration had no negative influence on the monitored parameters in broiler fattening. Comparison of the results with the control group didn´t show worsening parameters of fattening. The results were not statistically significant (P>0.05).

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